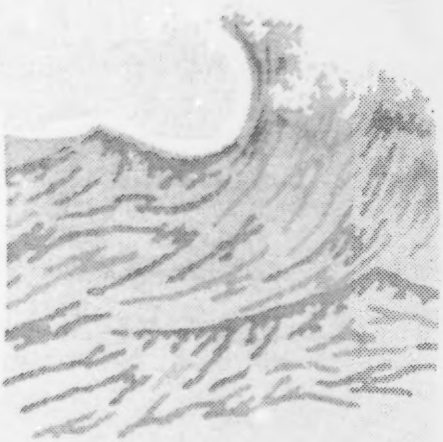
FISHERIES
RESOURCE
CONSERVATION
COUNCIL

A Report on Gear Technology in Eastern Canada

Report of the Gear Technology Subcommittee



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1. Introduction

The Fisheries Resource Conservation Council (FRCC) has addressed a number of issues concerning the conservation aspects of the management of Canada's Atlantic fisheries, in addition to providing advice to the Minister of Fisheries on the details of the annual management of the groundfish resources for the following year since 1993. This report considers the various fishing gears being used in the Atlantic groundfish fisheries and reviews the characteristics of the different gears that are relevant to the conservation of the resources and ecosystems. The document contains general and gear specific recommendations on means to address concerns about possible adverse impacts of fishing gear on resource yields and sustainability, and on the need to carry out further investigation of a number of the conservation concerns and of the means of addressing them.

The report does not attempt to rate gear types in terms of their possible impacts on the resources and ecosystems, or conversely on their "conservation friendliness", because there is insufficient information on the nature of the impacts that the different gears have on the resource and the ecosystems, over and above the general activity of harvesting.

The report highlights excessive harvesting capacity as a major problem for resource conservation. This is not a characteristic of any gear type, but without effective control of capacity, and its expression as harvesting effort, any initiatives to address gear specific conservation issues will not achieve their objectives, because the willingness to implement the changes will not exist.

Another element that must be addressed with respect to improving the conservation aspects of fishing gear is how to achieve this when management is not totally under Canadian control, such as on the Grand Banks and Georges Bank.

Background

The single fish, or the boat full of fish, brought to shore is not the only result of a fishing operation. In only a few fisheries will these fish be the only ones caught. There may be very substantial catches of species for which there is no direct use, or of sizes of fish of the desired species which are too small to use. All these unwanted catches are returned to the water, usually dead, together with any catch that has been damaged, or is of poor quality because it had been left in the water too long.

Unintended catches and the discharge of dead fish have long been recognized as problems that should be minimized, and many ways have been investigated to reduce them, and adopted where useful. Less attention has been paid, until recently, to other impacts of harvesting, such as the disturbance of the bottom by the action of fishing gear, the effects on species harvested unintentionally and the possible changes to the ecosystem from the removals (intended or accidental) of only some species.

The relative importance of these effects of harvesting varies according to the type of fishing gear being used, the specifics of its construction, the way it is being used, the species being harvest and, for groundfisheries, the nature of the sea bed in that locality.

The awareness of the importance of the effects of fishing not only on the target species, but also on the ecosystems and the physical habitat, has been growing rapidly both nationally and internationally. The awareness is reflected in the many references to such elements in recent international treaties and agreements such as the United Nations Convention on Biological Diversity, the UN Agreement on Straddling Stocks and Highly Migratory Stocks, and the FAO Code of Conduct for Responsible Fishing. Furthermore, initiatives such as the development of a Canadian Code of Conduct for Responsible Fishing, indicate that this awareness is being translated into practical terms. Domestically the decline of Atlantic groundfish stocks has emphasized the importance of taking all practical measures to avoid the possible adverse impacts of harvesting.

The FRCC and The Gear Technology Subcommittee

The Fisheries Resource Conservation Council (FRCC) was created as a partnership of government, the scientific community and industry, to make formal recommendations to the Minister of Fisheries and Oceans on Total Allowable Catches and other conservation measures for Canadian Atlantic and Eastern Arctic fisheries. The Council also advises the Minister on scientific research and assessment priorities and methodologies.

While the FRCC recognizes that direct management issues, including the selection of fishing gear, are beyond the FRCC's mandate, it is also clear that there are conservation consequences associated with the various types of harvesting gear and the ways in which they are used. As a result, the Council established a subcommittee that would examine the conservation consequences of gear technology. More specifically, the Gear Technology subcommittee was formed to determine for each harvesting technology, the conservation implications, the optimum manner of usage and the attributes from a resource conservation perspective. The work of the subcommittee was to be based on an objective analysis of historical experience and current evidence concerning habitat impact, gear selectivity, inherent manageability, and potential for improvement or abuse in the use of the various gears, and any other relevant considerations. The formal mandate is attached to this report, together with a list of members of the FRCC Gear Technology Subcommittee (Appendix B). **All the analyses and discussion are focused on the conservation aspects and are not intended to, and should not be interpreted as an effort to, address elements relevant to catch allocation among gear sectors.**

In the first phase of its work, the Fishing Gear Technology Subcommittee was empowered to commission an independent and objective study on the state of knowledge about the conservation implications of the major fishing gears used in Atlantic Canada, based on existing literature and on relevant experience. The study was conducted in collaboration with the Canadian Centre for Fisheries Innovation in St. John's and the Fishing Services Branch of the Department of Fisheries and Oceans in Ottawa, and was used to prepare a public discussion paper that described each gear's conservation-related advantages and disadvantages, including size- and species-selectivity, environmental and/or habitat impacts, manageability implications, and the potential for abuse. This discussion paper was released in December 1994 as "Conservation Aspects of Groundfish Gear Technologies in Eastern Canada" (FRCC.94.TD.4).

The discussion paper was used subsequently to develop draft conservation principles that would be applicable to fishing gear use and its design, and, for each gear type, to identify specific issues and potential recommendations for addressing them. These were published in January 1996 in a "Consultation Paper on Gear Technology" (FRCC96.TD.1). The paper was used as the base document for a series of seven public consultations during March and April 1996 in Atlantic Canada and Quebec, and for a teleconference with the Nunavut Wildlife Management Board, on the conservation aspects of groundfish fishing gear technologies. A summary of these consultations is provided (Appendix C), together with a list of the meetings (Appendix D) and a list of the briefs received (Appendix E). The conclusions of the consultations are mentioned also in the different sections of this report.

In general, the opinions expressed during the consultations and the positions put forth were as diverse as the fishery itself. While some of the discussions wandered off into areas that were outside the mandate of the FRCC, there were many fruitful debates and positive suggestions. There is tremendous concern that the fishery of the future will mirror the fishery of the past. Concerns about the amount of capacity that is sitting at the wharf, ready for the fishery to re-open, were heard at every consultation, indeed there were many observations that this capacity is increasing, at least in terms of its effectiveness. There are many people who believe that we must prevent gear technology, and fishing technology in general, from running away with us, as they believe it did in the past. Most feel that excessive harvesting power in any gear type is dangerous for the resource.

This concern about harvesting capacity was so prevalent that it proved impossible to exclude it from any discussion of the conservation aspects of the different fishing gears. The concerns were of two general types, one being that the excessive levels of fishing mortality during the 1980's were in large part the result of too much fishing capacity and the inherent pressures to achieve the economic returns demanded by the capital investment. These pressures were often expressed as resistance to reductions in TACs; through efforts to maximize the value of the catch, and through incomplete information on actual harvest levels The second category of concern tended to be more gear specific, and included worries about the way some gear types, and otter trawlers in particular, could seek out concentrations of fish wherever they were, and that high levels of effort could be diverted rapidly to these concentrations. This worry was not limited to the so-called "mobile fisheries" as the developments within the "fixed gear" sectors, and particularly gillnets were seen to have created the ability to generate heavy harvesting pressure on specific localized resources.

The FRCC reiterates that harvesting capacity must be controlled if initiatives to address the conservation aspects of fishing gear are not to be compromised by efforts to enhance economic returns.

Groundfish Conservation Strategy

A second initiative of the FRCC that is related closely to the work of the Gear Technology subcommittee, is the development of a Groundfish Conservation Strategy, including principles for conservation that would apply to all aspects of the management of the groundfish fisheries.

The principles relevant to the conservation aspects of Fishing Gear Technology are:

1. **Protect Resource Renewability**

   All activities including management decisions, the conduct of fisheries, enforcement, scientific studies and information gathering must be concerned with ensuring continuity of fish stocks. Relevant elements for such continuity include the maintenance of adequate spawning potential, ecosystem balance and function, and habitat.

2. **System Approach**

   A system approach to fisheries has to be considered in the decision making. This requires understanding of the interaction between the resource, natural environment, fisheries activities, technology, human behaviour and social and economic factors.

3. **Precautionary Approach**

   The FRCC supports fisheries conservation approaches that are "prudent" and holds that it should not be necessary to await final scientific analysis before taking conservation measures. It should be enough that on the balance of the evidence, it makes sense to take action; that is the Precautionary Approach.

4. **Consistency**

   This approach implies that all fishing activities should abide by the same principles, which should be consistent between areas and species. Conservation actions should be consistent over the entire range of a particular stock and they should be implemented with fairness and equity - no particular sector should bear alone the cost of, or benefit alone, from the measures.

5. **Accountability**

   All involved in fisheries must recognize how their role and actions contribute to an effective conservation program and must accept the consequences of their activity, be they fishers, fish buyers, association representatives, scientists, managers, policy makers, etc. It has to be kept in mind that conservation is compulsory, not optional.

6. **Understanding the Resource**

   The fundamental basis for achieving sustainable utilization of the resources is adequate information on the resource and the consequences of harvesting both on it directly and indirectly via the ecosystem and habitat. One aspect of accountability is that all involved must provide accurately and comprehensively, the information needed to develop the knowledge necessary.

7. **Flexibility and Responsiveness**

   This reflects the need for fisheries management measures to be modified as new information becomes available, whether this be from real time monitoring of changes in the resource and its environment or from the development of greater understanding of different biological factors.

Biological Characteristics of Fish Stocks

The various biological characteristics of fish stocks that need to be taken into account in fisheries conservation decisions include many that are relevant to this review of fishing gears.

The most obvious characteristic is that marine species of fish and invertebrates produce very large numbers of eggs, which is why fisheries can continue to harvest a large proportion of the population each year without the population declining from year to year.

This is because in most years there will be many more young fish than are needed to maintain the numbers in a harvested population, i.e. if there was no fishery, the population would increase. In some years however, there may be almost no young surviving. Thus even in unharvested populations there is considerable variation in numbers over the years and other factors such as competition for food limit the maximum numbers. The important element in fisheries management is to maintain adequate numbers of spawners so that enough eggs are produced and there is the potential for enough young fish to survive to harvestable size. Low spawning numbers, even if survival of the young stages is good, will not provide many recruits to the population.

In addition to consideration as to whether there are adequate number of fish of spawning age, another reason why fisheries managers must be concerned about the size of fish in the catch is the question of "yield". There is a time, expressed in terms of the age of the fish, when the total weight of fish of the same age is the maximum. Harvesting fish at a younger age means less can be harvested in terms of weight, because the fish have not completed their early rapid growth. Harvesting very old fish also means that less than the potential maximum can be harvested because losses to the population due to natural reasons are greater than the total weight added to the population through growth of the survivors. Thus, irrespective of whether fish are too small to be utilized, or whether there are economic considerations about different sizes, there is a biological reason for being size selective.

Another important factor relevant to both the maintenance of adequate spawning numbers and the amount that can be harvested in terms of yield, is the concept of exploitation rate and the size at which harvesting is started. Where the catch is spread over many ages of a fishes life span, the exploitation rate must be kept low because only a small proportion of the available population can be harvested each year, and still leave enough fish to survive to spawning age. Conversely, if harvesting is restricted to only a few ages, then the exploitation rate can be higher, given the shorter period during which the fish are being exposed to fishery. The actual weight of harvest will be a function of the actual ages because of the "yield" considerations.

A further biological element in the control of harvesting is the question of stock structure and the genetic basis for this. Under the classic concept of a "stock", it does not matter where harvesting occurs. If, however, there is some sub-structure to the population, in that components separate out from each other at certain times of the year, such as when spawning, then consideration must be given as to where harvesting occurs. Otherwise one component may bear a greater proportion of the total harvest from the stock than is appropriate. Concern about such an imbalance in harvesting components increases if there are genetic differences between the components, and thus components could be selectively fished down. It is important therefore, to understand the extent to which the catch by any gear is from the total stock or few components, if any. A related element is that of fish behaviour, and whether the action of the different fishing gears may have differential and/or detrimental effects on fish behaviour. The action of some gears may enhance feeding opportunities, at least in the short term (this is discussed in the section on "ecosystem impacts"), while concern has been expressed about disturbance of spawning behaviour particularly by mobile gear.

Information on this, like stock structure, is difficult to obtain, although modern techniques are providing the means to gather the necessary information.

The distribution of a number of groundfish stocks extends beyond areas of Canadian jurisdiction, which adds a complication to the implementation of measures to improve the conservation aspects of fishing activities. On the Grand Banks, NAFO has the authority to establish specifications for gear design and use in the area of the Grand Banks beyond 200 miles. On Georges Bank there are a number of groundfish stocks straddling the US/Canadian boundary. The recent UN Agreement on Straddling Stocks and Highly Migratory Stocks contains some provisions relevant to this problem with respect to the Grand Banks.

This review of biological characteristics that are important in considering, fisheries conservation has dealt so far with the characteristics of the targeted species. There remains the very extensive subject of the impacts of harvesting on the ecosystem. This is both in terms of the removal of certain elements, whether intentional or incidental, on the balance between species, such as in predator/prey interactions, but also in terms of ecosystem health. Much research is being carried out on the impacts of fishing gear on the seabed, but there is little information as to whether harvesting can have a detrimental impact on the overall functioning of the ecosystem. It is likely that this particular element will prove difficult to study, particularly in separating the extensive natural fluctuations between biological elements of an ecosystem, from any effects due to harvesting.

Conservation Principles with Particular Reference to the Use of Fishing Gear

The January 1996 Consultation Paper listed a number of draft "Conservation Principles" applicable to Gear. These were listed under the following headings:

A. Selectivity and Post-selection Mortality
B. Environmental Impacts
C. Manageability and Potential for Abuse, and,
D. Technological Development.

The public consultations and further discussion allowed the FRCC to develop recommendations on the use of particular fishing gears with respect to conservation concerns. These are provided on a gear to gear basis after a general review of the conservation related characteristics of fishing gear.

A. Selectivity and Post-selection Mortality

This category refers to the selectivity of the fishing gear in terms of those sizes of fish that are caught relative to the size range of fish that encounter the gear. The smallest sizes of fish may pass through the meshes or be unable to swallow the bait (and hence the hook), while the largest sizes of fish may be able to escape being captured either by swimming faster than the net is being towed or, in the case of gillnets, because they are too big to be trapped in the mesh. It should be noted that the actual size below which fish can pass through a mesh, or not become trapped (in the case of gillnets), is not a single length for a particular mesh size. In practice, the length at which all fish escape and the length at which no fish escape are usually 8-10cms apart. If the act of escaping the gear results in injury to the fish and it dies subsequently, this is referred to as "post-selection mortality".

D Selectivity

The first principle with respect to selectivity, as outlined in the Consultation Paper, and now endorsed by the FRCC is that **"all fishing gear should be capable of targeting a range of fish sizes of the directed species"**. This was supported widely in the consultations but leaves open the question of how broad a size range should be harvested and whether all gears should be limited to the same size range. There was general agreement that excessive harvesting of small fish should be avoided and there was frequent reference to delaying harvesting until the fish had reached spawning age.

All fishing gear should be capable of targeting a range of fish sizes of the directed species.

On the general principle as to whether each particular gear type should harvest a range of fish sizes, there are a number of considerations, but primarily the fishing action of the particular gear. For example, in the net fisheries it is possible to adjust mesh size and thus to control, in general the minimum size taken. Longlines and hand lines (collectively described as hook and line) are less selective for size; experiments have shown relatively weak selectivity according to hook size, although bait size does have some influence on the size of the smallest fish in the catch.

The various gear types have different characteristics with respect to catching the larger sizes of fish. Otter trawls and Danish seines are less efficient in catching large fish in terms of the proportion that they catch of the available population at these sizes. They are more efficient for smaller sizes in that they take a high proportion of the numbers of such fish that encounter the gear. In other words, larger fish tend to escape being caught in otter trawls and seines more readily than smaller fish, whereas gillnets in particular, can be targeted at larger fish, through changing mesh size.

The different fishing characteristics of the various gears mean that it would be difficult to insist that all gears harvest the same range of fish size. The lower end of the size range can be controlled for most gears, but the upper fish size can be controlled most easily for gillnets. Furthermore, any attempt to limit the gillnet and hook and line fisheries to catching only the same size range of fish as taken by otter trawls and Danish seines would be a significant change as these fisheries have traditionally harvested a wider range of fish sizes particularly the larger sizes. Cod traps present a different problem in that they in general harvest very small fish, quantities of which are discarded or damaged by being meshed in the gear. It is, however, agreed generally that changes must be made in the harvesting pattern of this gear. Thus, without addressing the question of deliberate targeting of very large fish (see next paragraph), it is recommended **that harvesting should be spread over a range of fish sizes, but the principle should be applied in terms of the total fishery rather than requiring each gear type to harvest the same size range.**

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The question of how big fish should be before they are harvested includes the option of harvesting only mature fish. The FRCC discussion documents referred to the concept of "allowing fish to spawn at least once before they were caught." This suggestion was debated widely during the consultations and opinions were varied. Indeed, it was argued that such a measure was unnecessary, if fishing mortality was held at a conservative level, such as F0.1 or lower, rather than being allowed to be much in excess of that level as had proved to be the case in the past. Under a regime of low fishing mortality, a significant proportion of the population would survive to older spawning ages, even if harvesting occurred on pre-spawning age groups.

An important factor, however, in any move to limit harvesting to sizes of fish above that at which they would have spawned once, is the practicality of such a measure. The overall effect would be that much more effort would be needed to achieve a target exploitation level such as F0.1, and hence catch rates would be reduced greatly. It is true that there would be long term benefits of not catching small fish, and the TAC would increase gradually over a number of years, but this increase would not compensate for the reduced catch rates due to changing the size at which the fish were first harvested.

These conclusions may appear surprising and perhaps contradictory, but are due to a relationship between how long a fish is vulnerable to the fishery, in terms of its potential life span, and the level of effort needed to achieve a target harvest rate. In the simplest example, if the average life span of the species is 10 years, and fishing is limited to a single age, e.g. age 6, then correspondingly more effort will be needed in the relevant year to catch the appropriate amount from that age class, than if the harvesting were spread over several ages (e.g. ages 3-9).

A modeling exercise was undertaken by DFO (see box) as to the effect of introducing a mesh size that

only harvest cod at the size at which they could spawn. The analysis was run using information for Southern Gulf of St. Lawrence Cod and showed that the TAC could, over time, be 30% higher, in comparison to when fishing with 130mm diamond mesh, but the amount of effort required would be more than double right from the start. The catch rates with the larger mesh (150mm in the example) would therefore be only 60% of what would be taken with 130mm diamond mesh even after rebuilding, and it is questionable whether the use of larger mesh would be respected because vessels using smaller mesh would obtain greater catch rates. The changes in catch rates and TACs are shown in the graph.

Another practical element of the increased mesh size would be that fish of commercially acceptable size would be extruded through the meshes at haul-back and be seen to float away. In the case of cod, and 150 mm diamond mesh, some fish in excess of 60cm would be extruded and be seen to float away dead. This, in combination with the relatively low catch rates, might further mitigate against the effective implementation of the measures.

Modeling the Impact of Catching fish only when they are big enough to spawn

The model was run using biological data for the cod stock in the southern Gulf of St. Lawrence (4TVn). Most of the cod (95%) are capable of spawning by the time they grow to 47cm. The mesh size that would allow fish to escape until that length is estimated to be 150mm diamond mesh. This mesh would still retain about 5% of the cod of 47 cm that entered the net.

Calculations were made as to how the catch and catch rates would change from year to year if fishing at the $F_{0.1}$ mortality level with 150mm mesh, in comparison to what would be expected if fishing at $F_{0.1}$ with 130mm mesh. As might be anticipated, in the first year the TAC and catch rates would be much less using 150mm mesh, and after five years, because of greater survival of small fish, the TAC would increase.

The model estimated for the stock in question, that the TAC would be about 70% in the first year of what it would be if the mesh size had been left at 130mm., and would increase by perhaps 50% after five years. If fishing had continued with 130mm mesh the TAC would have declined somewhat. Catch rates with 150mm mesh would start at about 40% of those that would be achieved with 130mm and although they too, would increase by 50% they would never be the same as would have been achieved at the outset with 130mm mesh. This startling conclusion illustrates a very important feature, i.e. that the older the individuals are in a population before they are harvested, the more intense the fishing pressure necessary to achieve a target exploitation rate. This is because the fishing mortality associated with a target exploitation rate such as $F_{0.1}$ is a function of the period during which they are subject to harvest, thus the fewer years the stock is fished, the higher the target fishing mortality level. In this case the instantaneous fishing mortality rate associated with the $F_{0.1}$ exploitation level raises from $F_{0.2}$ to $F_{0.5}$ when switching mesh size from 130 to 150mm.

Given the conclusion that delaying harvesting until the age of maturity will result in high levels of fishing effort and lower catch rates, and, the expectation that it is therefore unrealistic to believe that such a measure could be implemented effectively, there remains the question of how large a fish should be before it is harvested. At present minimum sizes are specified in the regulations but they are universally regarded as having been ineffective in stopping the killing of small fish. The more recent management technique of establishing "small fish protocols" is considered to have been effective in keeping catches of small fish under control. These protocols specify that should the percentage of fish below a certain size in the catch of a specified number of vessels exceed a predetermined level, fishing is suspended until test fishing shows that it is possible to resume fishing without catching small fish in excess of the level specified. At present, however, the protocols use the old minimum sizes which have little biological basis. Controlling fish size can be considered in terms of the concept of maximum yield per recruit, which was referred to earlier in the section on biological characteristics, but the size of fish at which the yield is maximized

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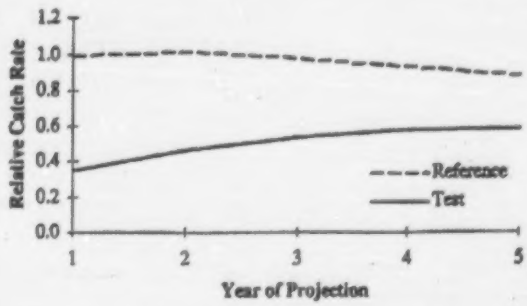
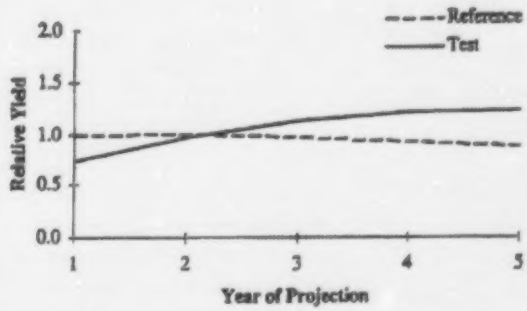




Graphical representation of changes in relative catch rate and relative TAC over 5 years time period using 130 mm and 150 mm mesh.
[Sinclair - Chouinard. Fig.4&5]

is close to the size at maturity for groundfish. Consequently a fishery designed to maximize the yield will be characterized by the same features as described for a scenario of delaying harvest until the fish have reached spawning size. This means that there is no obvious basis for selecting a particular size other than to use as a general principle, that fish should not be caught until they are sufficiently large to be utilized. The objective of this would be to avoid waste, both in the form of small fish being caught and thrown overboard and in the form of losing too much of the potential growth. There are, however, some international markets for very small fish, e.g. redfish and flatfish, but these particular markets should not be considered acceptable "utilization" because the fish are so small that total catch from the particular stocks could be much higher, for the same effort level, by allowing the fish to grow. This practice should therefore not be covered by the rule of thumb on fish size and it is recommended that the principle be phrased as **"unless this would result in significant loss of yield from the fishery, the smallest size of fish caught should be that which can be utilized"**.

The practical implications are that gear specifications should be selected to achieve this goal, supplemented by area and season controls as appropriate. Whether or not the size of the fish is specified as a minimum in regulation is a matter that should be determined when implementing the relevant management strategy, but it would appear appropriate to continue the use of small fish protocols so that fishing is suspended should numbers of small fish in the catch reach a pre-determined level. Under such a regime, it can be made mandatory that all fish are landed irrespective of size.

Any discussion as to whether there should be controls on the largest sizes that can be taken should be in the context of maintaining an adequate spawning stock and of allowing some fish to die of old age. The underlying requirement in maintaining an adequate spawning stock is to restrict total harvesting to a rate that will allow sufficient numbers of fish to survive to old age. This control of harvesting rates may be supplemented by avoiding the capture of small fish and by protection of part or all of the spawning stock. Whichever approach is taken, and particularly given recent research that indicates that older fish make a greater relative contribution to spawning success, through increased fecundity (number of eggs), larger, more viable eggs, and longer spawning seasons, it is recommended that fishing should not be allowed to specifically target the older spawning ages. This will require an upper mesh size for gillnets and, if there are known concentrations of such fish, area and season limitations on all gear. This latter type of measure would be particularly important for hook and line gear as this gear type has been seen to target concentrations of the largest spawners.

A related problem is the ability of gillnet fisheries, in particular, to target strong year classes as they pass through the fishery by changing the mix of mesh sizes in use so as to match the current fish size of the dominant year classes. This practice increases the level of fishing mortality on such year classes by changing the overall selectivity pattern of the fish-

ery, and reduces the contribution of strong year classes to the spawning stock, and particularly to the older spawning ages. Since this is also not consistent with adequately protecting the spawning stock, restrictions should be placed on the freedom of the gillnet fisheries, in particular, to change the selectivity pattern (by varying mesh sizes), from year to year. The selectivity pattern is a reflection of the efficiency of harvesting the various ages (sizes) of fish, and should not be confused with selectivity of mesh sizes although this latter concept contributes to the former. Important components determining the selectivity pattern in addition to mesh size are the relative availability of the different sizes of fish in the fishing area, and the ability of fish of different ages to escape being captured.

This implies a need for a standard against which changes in the selectivity pattern of a particular gear type can be measured and this could be the overall selectivity pattern for the fishery over a period of years. The overall selection pattern of the total fishery will not match that of any gear type, but by using an average of the pattern over several years as the standard, changes in the selectivity of one gear type could be recognized. This standard would need to be adjusted should the distribution of fishing opportunities be altered between gear types, but such alteration would also require recalculation of the catch expected from the stock at any target exploitation rate.

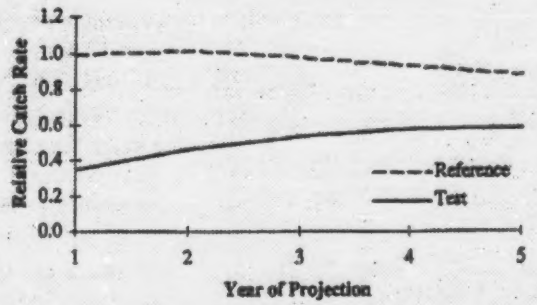
It is recommended therefore that "the size selectivity of individual gear types should not differ significantly from the size selectivity of the overall fishery".

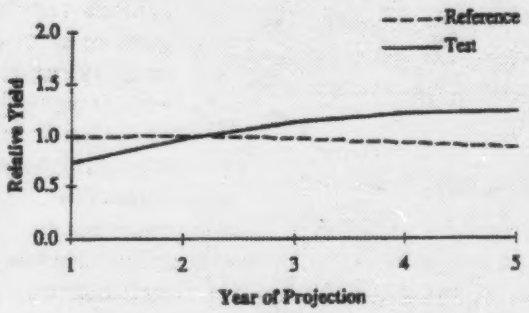
Under such a regime, catches by all gear types would be covered by the same small fish protocol, but it must be expected that neither the range of sizes caught, nor proportions of age, would be the same.

The third element of selectivity is the incidental harvesting of non-target species. This has two elements depending upon whether the species is one of commercial value that may be targeted in other fisheries, but not in the particular fishery in question (e.g. cod taken in the winter flounder fishery) or whether the species is not of commercial value nor the subject of any directed fishery. The first case will be referred to as an incidental catch of a "commercial species" and the second as "non-commercial species". Incidental catch of commercial species can itself be sub-divided according to whether the catch is retained or discarded. The former becomes an allocation issue in that it concerns who catches what, but any fishery taking commercial species that cannot be utilized either because of the size of the fish, or for quality reasons such as inadequate storage facilities, is generating waste. Avoidance of such waste may be possible by adjusting the specifics of the gear (e.g. hanging ratios of twine, nature of the top cover in trawls and seines, mix of mesh types, selector grids, split codends, etc.), the way the gear is used, the locality and/or the season. Such research should be complemented by studies of fish behaviour in relation to gear, since there are different behaviour patterns shown by the various species which can be utilized in designing means of separating them in the catch.

The incidental harvest of "non-commercial species" is another form of waste, in that the catch of these species is not utilized. The impact on these other species will be considered further in the section on Environmental Impacts but as a principle it is recommended that such catches should be kept as low as possible. Additional measures should be implemented when even low levels of incidental catch can be harmful to populations of animals already reduced to numbers that cause concern, e.g. harbour porpoise, salmon and some species of sea birds.

As a general principle "incidental harvest should be held at the lowest level possible and that there should be continuing efforts to develop means of achieving this through modification of the particular gear, the way it is used, the season and/or the locality, as appropriate".





Graphical representation of changes in relative catch rate and relative TAC over 5 years time period using 130 mm and 150 mm mesh.
[Sinclair - Chouinard. Fig.4&5]

is close to the size at maturity for groundfish. Consequently a fishery designed to maximize the yield will be characterized by the same features as described for a scenario of delaying harvest until the fish have reached spawning size. This means that there is no obvious basis for selecting a particular size other than to use as a general principle, that fish should not be caught until they are sufficiently large to be utilized. The objective of this would be to avoid waste, both in the form of small fish being caught and thrown overboard and in the form of losing too much of the potential growth. There are, however, some international markets for very small fish, e.g. redfish and flatfish, but these particular markets should not be considered acceptable "utilization" because the fish are so small that total catch from the particular stocks could be much higher, for the same effort level, by allowing the fish to grow. This practice should therefore not be covered by the rule of thumb on fish size and it is recommended that the principle be phrased as **"unless this would result in significant loss of yield from the fishery, the smallest size of fish caught should be that which can be utilized"**.

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II) Post-selection Mortality

There is concern that achieving size selectivity through such measures as controlling mesh size may have a cost in terms of injury and subsequent death, to some of the individuals, particularly those that are sufficiently large that they are a "tight fit" to the mesh size as they squeeze through. A number of experiments have been conducted to examine this and the results generally suggest that survival is good for fish escaping when the gear is at fishing depth. The mortality level is higher, however, for fish escaping as the gear is hauled back, and particularly near the surface for those species with large swim bladders, since the bladder will expand either causing injury directly or preventing the fish from being able to escape the surface.

Recent experiments on longer term survival of fish passing through meshes at the fishing depth have involved collecting the escaping fish and holding them in a cage on the bottom. The survival rate has been compared with other fish in the same cages, but which were caught by trap on the bottom and therefore were not subject to being caught in a trawl and escaping. The results are somewhat variable, with a trend for higher survival of escapees through larger mesh, and for higher survival amongst the larger escapees. This latter point is somewhat surprising as the larger sizes of escapees might be expected to suffer the most damage as they squeeze through the meshes. This may indicate that at least some of the causes of mortality are operative before the fish escape and may be associated with contact with other elements of the catch such as spiny invertebrates and stones, garbage and other non-living material. If this is so, it might be addressed by utilizing devices such as grids, to separate the fish component of the catch from the rest of the catch.

The results of the cage experiments suggest survival of cod is high, close to 100%, but that for haddock it is lower (82-97% surviving). There is no information currently available for flatfishes when using mesh sizes applicable in Canadian waters nor when the fish were held at depth after escaping, as compared to being sorted on deck and then returned to the sea. Some preliminary work has been carried out on redfish selectivity mortality that indicates that 18-30% of the escapement is during haulback when using 130mm diamond mesh and thus these fish may die, but there has not been any work on survival of the other 70-82% that escape when the trawl is still at fishing depth.

More information is required on the survival of fish after escaping, and particularly whether possible additional measures to increase the selectivity would increase the mortality amongst escapees. As a general principle **"measures to improve selectivity should not increase mortality amongst escaping fish"**. Indeed research should be continued into quantifying such deaths and on ways to reduce them, be they caused directly or by predation on weakened animals. This area of research is of great interest to all fishing nations, and cooperation between research programs internationally would be particularly effective in making best use of the resources available.

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The impact of post-selection mortality is compounded by the fact that such mortality is not taken into account in current stock assessments and thus increases the uncertainty in the assessments. Nor is post-selection mortality the only unknown component of the total deaths due to fishing, since an unknown amount of the catch may never be seen, particularly in gillnet and longline fisheries. Scavengers remove fish from the gear, and other fish are dislodged from the gear by wave or current action, or during haul-back (the so-called "drop-out", or "float-out" problem). Improvements in gear design and/or use to reduce such losses from the gear (e.g. hook design) and research to quantify their extent and that of scavenging losses, will improve both the economics of the fishery and the precision of the data for stock assessment.

A further source of unquantified loss to the resource is the capacity of some gears, particularly gillnets, to continue to "ghost fish" if left behind on the bottom by accident, but this is not a selectivity question and will be discussed later. It is noted here for completeness of the review of unquantified fishing mortality.

B. Environmental Impacts

In addition to effects of removing both target and non-target species directly, or as a result of post-selection mortality, the actual act of fishing may have a number of other impacts on the environment, both biological and physical. It is clear that the relative abundance of the different species is altered significantly by fishing activity, but what is not known yet is whether the biological productivity of an area is increased or reduced, and if so to what extent. Research into such factors is complicated greatly by natural environmental fluctuations and other man-made factors since it is very hard to separate out the causes of any changes. From a fisheries viewpoint, the impacts may not reduce the amount of catch, although the species composition may change, but there are two other aspects, one being the integrity of the ecosystem, and whether the cumulative impacts of fishing activity could disrupt the functioning of the ecosystem. Such disruption would likely also cause loss in productivity as noted above. The other aspect is that of biodiversity and in particular the maintenance of the full range of species, and their genetic variation. In this respect, an important component is the distribution of fishing effort with respect to the total habitat, and particularly whether there are localities within the general area where disturbance by fishing is minimal and thus whether there are areas where species that may be sensitive to disturbance are preserved . Studies on the fine-scale distribution of fishing effort, and analysis with sidescan sonar of the tracks of trawl doors, do suggest that fishing is highly "patchy" in its coverage of a general area. An area where there is no fishing may be one where the bottom is too rough to fish, or it may be that the nature of the bottom does not attract commercial species. Further investigation is needed to determine why there is this apparent patchiness in fishing average, and hence how relevant it is to the maintenance of biodiversity and the significance of fisheries related disturbances.

Much of the attention on impacts and their implications has focussed on the seabed. The nature of these impacts varies according to the nature of the seabed and according to the gear, and the significance is not well understood but is likely very variable. Physical injury to seabed animals as a result of being "run over" by the gear will increase the non-harvest mortality, but may also provide improved feeding for other animals. Such impacts will be greatest with the more intrusive gears such as scallop rakes, clam dredges and beam trawls, although the latter are not widely used in Atlantic Canada. The trawl doors of an otter trawl and the foot rope of the trawl itself, are intended to glide over the bottom rather than dig in, unlike the other towed gears where the harvesting action requires scraping the bottom. In fact, the less the otter trawl digs into the bottom, the less energy that is needed to pull it, and the faster it can be towed. Indeed much of the research on improving harvesting efficiency and in reducing energy consumption addresses this. Trawl doors do leave a furrow in soft bottom that may persist for some time or disappear rapidly depending upon the nature of the bottom (sand or mud) and upon the strength of water currents and the amount of storm turbulence that reaches the bottom.

It appears that at least in some softer bottom types, the physical nature of the substrate changes as fishing gear passes over, and it becomes more fluid, which results in smaller animals being swept aside rather than being run over, even when buried within the seabed. The action of towed gear may however turn over rocks, break off protruding structures such as worm tubes, coralline algae, etc., and stir up sediment. In this connection it is noted that rock hopper trawls are intended to "hop" over rocks and thus reduce the tendency to turn them over. The clouds of sediment from the trawl doors, dredges or rakes, may have adverse impact on some animals but the clouds generally settle rapidly, and there may be beneficial effects from the release of nutrients from the substrate back into the water column.

The impacts on the many seabed species are not well known. Some species are very sensitive to mechanical disturbance, whereas others appear well able to tolerate disturbances and yet others appear to benefit. Changes in the "topography" of the bottom even at the scale of small pebbles, can alter the ability of prey to hide from predators and also the amount of surface area available for the attachment of sedentary animals.

There has been some research on the impacts of fishing gear on the seabed, both in terms of physical disturbance and the biological effects. To date many

of the studies have dealt with the more obviously disruptive types of gear (e.g., scallop dredges, beam trawls and clam dredges) but there are an increasing number of studies currently underway around the world to quantify the impacts of other gear types. Of note in the Canadian context, are trawling impact experiments in a protected experimental site on the Grand Banks, and work in Minas Basin. There is a proposal to carry out a trawl impact study within the haddock nursery area of 4W (Central Scotian Shelf), where bottom trawling and gillnetting have been prohibited, although there is scallop dragging in some of the area. Scientists in the USA are also carrying out research into trawl impacts, which includes work on Georges Bank, where some specific area have been closed to fishing and the changes in the seabed and the bottom species are being monitored.

The Consultation Document recognized that the actual act of fishing causes physical disturbance of the seabed and may have other environmental impacts. It was proposed in the document, that a conservation principle should be that the impact of the various gear types "must not be detrimental to the ecosystem." Most of the participants in the consultations accepted this principle although there was considerable debate as to the meaning of "detrimental" and how that would be determined.

It is premature to draw conclusions about seabed impacts, and particularly the balance between possible detrimental and possible positive elements. In any case these elements will vary according to gear type and variety, between seabed types and between areas and the significance be influenced by the proportion of the seabed actually fished. It is recommended therefore that **the impact of the various gear types must not be detrimental to the ecosystem, that possible measures to reduce the impacts be kept under review, and be implemented as they are judged to be effective, with priority where data suggest possible detrimental effects on productivity, ecosystem functioning or endangered species.**

It is therefore important that research be continued, not only into physical and biological impacts, and whether these are reversible, but also into gear design that will reduce disturbance. An example of such gear design would be alternates to bottom-tending otter boards (trawl doors). In this general area, also, as with research on post selection mortality, cooperation internationally among scientists will be very beneficial to increasing understanding of environmental impacts.

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C. Manageability and Potential for Abuse

The discussion papers proposed that:

I. **a)** The implications of fisheries management decisions in conservation must be fully understood;
b) Fishing gear must not be adjusted or used in a way that will compromise conservation objectives;
c) All regulations specifically developed to protect fish stocks should be more rigorously enforced.

II. With regard to meeting conservation objectives, the potential for abuse of each fishing gear must be fully understood.

The consultations indicated general agreement, but some uncertainty as to how the proposals Ia.-Ic. applied to the conservation aspects of gear technology. There was, however, strong agreement that violation of gear regulations should be prosecuted to the full extent of the law.

It is here recommended that the fundamental principle should be a restatement of proposal #II concerning potential for abuse, to "require an evaluation as to whether the proposed measure will be implemented effectively or whether it is likely to be ignored and if ignored, whether it will be detrimental to conservation". An example of a measure that might be detrimental could be the introduction of measures to limit harvesting to spawning age fish, since this would permit double the effort appropriate to fishing at $F_{0.1}$ with 130mm diamond mesh, yet there would appear real potential, in some areas at least, that the use 150mm diamond gear would be compromised by efforts to increase the catch rates and to prevent loss of acceptable sized fish through reducing the effective selectivity of the nets. The overall result would be to have a fishery still using 130mm mesh in effect, but allowed to harvest twice as hard as it should for that mesh size. Another example, which would be detrimental, would be a measure to limit the number of gillnets that could be set per vessel. Often this is established in such a way that vessels using less nets would be allowed to increase the number up to the new limit. A major problem is the ability of fisheries to increase effective effort and thereby undermine the principle of setting TACs based on constant effort.

Part of the effective implementation of conservation measures is a thorough understanding and acceptance by all parties of the intent of the measure, and there must be verification that the measures are being implemented effectively. The extent to which such verification must take the form of enforcement will depend upon the level of acceptance of the measures(s) and the implications for fishing practices.

D. Summary of Conservation Principles with Particular Reference to the Use of Fishing Gear

The overall conservation principles for Gear Use, can be summarized as that:

i) the specifications of the gear used should be determined on the principle that fishing on any stock should be spread over a range of year classes and fish sizes, while maintaining an adequate spawning stock biomass;

ii) there should be measures to prevent the catching of small fish, preferably through utilization of small fish protocols, and measures to prevent targeting on the older spawning ages, should be introduced;

iii) waste should be minimized through the following:

- **a) unless this would result in significant loss of potential yield, the gear should be designed to avoid capturing commercial species at sizes smaller than can be utilized,**
- **b) gear should be designed to avoid capturing non-target species to the extent possible**
- **c) changes in gear to improve selectivity by size or species should not result in increased post-selection mortality, but rather that such mortality as well as post-harvest losses should be reduced, and**
- **d) recognition that it is imperative that neither the method of utilization, nor the construction of gear, compromise the intent of conservation.**

iv) any proposals to introduce or change measures controlling gear design, type, or method of use, should be evaluated as to whether the proposed measure can be implemented effectively, or whether they would likely be ignored, and if ignored, whether it will be detrimental to conservation.

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iv) any proposals to introduce or change measures controlling gear design, type, or method of use, should be evaluated as to whether the proposed measure can be implemented effectively, or whether they would likely be ignored, and if ignored, whether it will be detrimental to conservation.

v) **the impact of fishing gear should not cause changes to ecosystems, including seabed habitats, that result in loss of biodiversity.**

vi) **additional research is needed not only into the physical and biological impacts of harvesting on the ecosystems and habitats, but also on means of addressing any harmful effects.**

vii) **management decisions should be made in the context of the precautionary approach.**

Gear Technology Proposals for Major Gear Types

There have been volumes written on the various gear technologies used to prosecute groundfish fisheries. It is safe to say that there is sufficient documentation available to support any position put forth about any gear.

In many cases, the debate about what type of gear is appropriate focuses on the efficiency side of the equation. Many times during the consultations the question was asked "once the quota is set, why should it matter what kind of gear is used to take that quota, a dead fish is a dead fish?" On the surface, this view makes good sense, and probably in an ideal world it would not matter. However, in the past we have lived in, and undoubtedly still live in, a very imperfect world with tremendous amounts of uncertainty. Therefore, our ability to control gear use must be improved.

We also heard often during the consultations, "I did not cause the problem, why should I change?" The reality is that with stocks at such low levels there need to be changes in all sectors to allow rebuilding of the fishery while some semblance of a commercial fishery carries on.

The fishery of the past was characterized by increasing amounts of gear, and increasingly more efficient gear and vessels. The ability to find and catch fish grew at a rate beyond which Science and managers could keep up. As was noted on numerous occasions during our public consultations, our past record has not been good and there is very little confidence that we will do better in the future.

The catch rates of most gear types are not necessarily reflective of the size or health of the stock. It is widely agreed that as an industry, as fishery managers and as fishery scientists we have no empirical knowledge of the net effect of the introduction of new or modified technologies into the fishery, on the assessment process, on the at-sea practices of fishermen, on the catchability of the resource and, ultimately on the resource's ability to sustain itself.

There were countless suggestions that it is not the gear that is the problem, but rather the people who use it and the way in which it is used. There was a very loud and clear message "get the pirates off the water."

The contribution by the different gear types has varied over the years but catches by otter trawl have dominated the total groundfish catches from the Northwest Atlantic since the arrival of the distant water fleets in the 1960s, and have been the major component of Canadian groundfish landings for almost as long. The Canadian landings by gear type are shown in **Figure 1**.

The contribution by the different gear types has varied also depending on the species sought. Redfish have been taken exclusively by otter trawl, while the only groundfish species taken by trap is cod.

The dominance of catches by otter trawlers were often cited during the consultations as the basis for blaming otter trawls for the decline in the fish stocks. This is an over-simplification. There is overcapacity in all fleet sectors. For example, harvesting pressure by fixed gears have contributed to declines in bay cod stocks along the east coast of Newfoundland. Other participants recognized the likely mix of factors, including overfishing and other elements such as the environment and abusive fishing practices.

One element that is not obvious from the graph is the way that the otter trawl fleets were able, prior to the development of the Atlantic Groundfish Management Plan, to switch from stock to stock in order to maintain the landings as high as possible. Indeed one of the conservation concerns often expressed in the consultations is the flexibility of otter trawl operators to find whatever concentration of fish may exist and to harvest it to the extent per-

v) **the impact of fishing gear should not cause changes to ecosystems, including seabed habitats, that result in loss of biodiversity.**

vi) **additional research is needed not only into the physical and biological impacts of harvesting on the ecosystems and habitats, but also on means of addressing any harmful effects.**

vii) **management decisions should be made in the context of the precautionary approach.**

Gear Technology Proposals for Major Gear Types

There have been volumes written on the various gear technologies used to prosecute groundfish fisheries. It is safe to say that there is sufficient documentation available to support any position put forth about any gear.

In many cases, the debate about what type of gear is appropriate focuses on the efficiency side of the equation. Many times during the consultations the question was asked "once the quota is set, why should it matter what kind of gear is used to take that quota, a dead fish is a dead fish?" On the surface, this view makes good sense, and probably in an ideal world it would not matter. However, in the past we have lived in, and undoubtedly still live in, a very imperfect world with tremendous amounts of uncertainty. Therefore, our ability to control gear use must be improved.

We also heard often during the consultations, "I did not cause the problem, why should I change?" The reality is that with stocks at such low levels there need to be changes in all sectors to allow rebuilding of the fishery while some semblance of a commercial fishery carries on.

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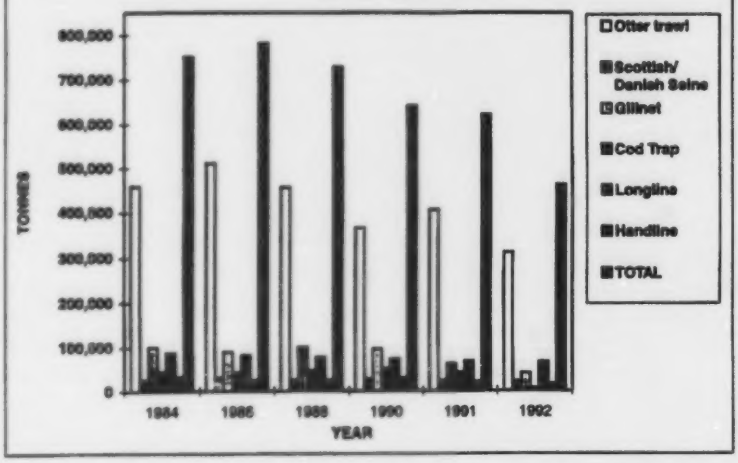
Figure 1: Trends in Atlantic Canada Groundfish Landings by Gear Type



GEAR TYPE	1984		1986		1988		1990		1991		1992	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
Otter trawl	459,543	61	512,287	66	457,136	63	368,110	57	408,821	65	311,880	67
Scottish/ Danish Seine	26,536	4	30,735	4	23,701	3	26,897	4	22,598	4	21,919	5
Gillnet	100,579	13	89,969	12	99,526	14	96,118	15	61,772	10	40,407	9
Cod Trap	45,070	6	41,967	5	48,049	6	51,190	8	41,743	7	6,247	1
Longline	88,128	12	82,394	11	78,336	10	73,091	11	67,878	11	66,184	14
Handline	32,429	4	23,988	3	24,606	3	29,144	5	21,100	3	15,506	3
TOTAL	752,287		781,340		728,783		641,550		621,910		462,253	

mitted by the regulations. The concern being that if the catch controls are overly optimistic, this ability of the otter trawlers translates this over-optimism into excessive fishing pressure. Furthermore there are concerns that the otter trawlers in particular, can harvest specific spawning concentrations and if these are genetically different (i.e. separate stock components) may not take the appropriate level of catch from the different concentrations. This could result in overharvesting one or more of these elements.

In summary, it is not a direct conservation aspect of the gear type per se, there is a great deal of concern that the flexibility of the otter trawlers in terms of area and season and its abilities to fishing rough weather can exacerbate any management errors. Herein is what most point to as the single biggest problem with this technology. Pointing to the otter trawl's ability to harvest good catches virtually to the point of stock collapse, Dr. Les Harris once said, "the last tow of Northern Cod will be a beautiful tow." The catching power of otter trawls also raises questions about the ability to catch non-target species and sizes of fish, as well as the potential for abuse of the gear. This leads to widespread calls for limitations on the capacity of the otter trawl fleet, so that fishing is spread over time and cannot catch all the relevant allocations rapidly at a time when the fish happen to be particularly concentrated.

This focus on the otter trawl, is driven as it is by the dominance the technology has had in the past, tends to mask the ability of the other gear types to be as efficient when conditions are right and to themselves generate conservation concerns about overfishing stock components (cod traps, deep water gillnets) smallfish, bycatch, ghost fishing etc. It is recognized that in recent years, some of the so-called "fixed gears", and particularly gillnets, have developed a much greater flexibility in finding fish in addition to increasing effort. It is noted also, for example that in the year cod were seen to decline rapidly, cod traps in some areas were still able to have "beautiful" seasons.

Otter Trawl

This gear sector has the ability to catch large volumes of fish in a short period of time and to fish in very unfavourable conditions and at any time of the year.

Throughout our public consultations on gear technology we were consistently told that the power of this gear must be controlled. The ability to catch small and non-target fish must be reduced, and to the extent possible the potential for abuse of the gear must be minimized. It was pointed out that in some areas the use of otter trawl could be damaging to bottom habitat. It was also noted frequently that trawls and Danish seines are the only effective way of harvesting some species.

In recent years there have been significant changes made to this gear through the introduction of square mesh, large diamond mesh, lastridge ropes, and sorting grates. The developments, however, have different implications for different types of fish. Square mesh enhances the escapement of round-bodied fish such as the gadoids, but reduces the escapement of flatfish for a given mesh size. Redfish selectivity poses different problems because the spiny bodies and fins mean that the range of sizes escaping is much greater for a given mesh size than for the gadoids and flatfish. This means that a mesh size selected to allow high escapement of small fish will still allow escapement, particularly at haulback, of much larger fish.

Gillnets

While gillnets are one of the most widely used of all groundfish gears they were virtually unheard of in Eastern Canada prior to the 1960's. The gillnet is efficient in catching fish and is widely hailed as being very size selective. It is capable of being fished in depths of water as great as 1600 meters, for almost all types of groundfish. While it can be very size selective, generally speaking, its ability to select for species is poor, and there are many concerns about the loss of fish to ghost fishing, incidental catches in some areas of threatened species such as porpoises and salmon, and waste due to quality deterioration if nets are not properly tended and are left in the water too long.

In our public consultations both the positive attributes, (the size selectivity, and efficiency) and the negative attributes, (incidental catches of other species, the ability to target certain stock components, the potential ghost fishing, and the potential for waste if the gear is not properly tended) were pointed out. Most mentioned that ghost fishing is not a problem in all areas, if the nets are tended properly and if the number of nets in use was low enough. Indeed under

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these operating conditions there would also be little waste due to poor quality.

In areas where gear loss occurs, it was recognized that there should be consideration of measures to limit the number of nets used and the length of time they are left in the water. As well, measures should be considered to require adequate gear specifications for the area, and deployment of transponders or other means of facilitating recovery of lost nets.

There was tremendous concern expressed, mostly by gillnet fishermen along the northeast coast of Newfoundland, about the impact of gillnets on bay stocks of cod and turbot, the Virgin Rocks cod fishery, and the deep water fishery for Greenland halibut. Many people were concerned that gillnet fisheries have resulted in rapid depletion of stocks, in part because of the ability of the fishery to increase effort in an almost invisible manner, by increasing the number of nets, and by reducing mesh size as the numbers of larger fish decline and only smaller fish were available. The increase in the number of nets and the decrease in mesh size is a common feature of the history of gillnet use, where in the early days of each fishery the stock was pursued with very large mesh; i.e., 7.5 - 8 inches, and invariably as the larger sizes were caught, and the stock declined, the mesh size decreased in many cases to 5 - 5.5 inches. Conversely, in recent years, where the fishery located pockets of large fish, reverting to larger mesh allowed a short-lived directed fishery on these large fish.

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4. **In order to minimize waste of harvest, protocols should be established that limit the amount of gear permitted to that which can be handled in a reasonable time period for the vessel size and area, and that restrict the length of soak time.**
5. **In areas where there is a potential for gear loss, and hence for ghost fishing, this shall be taken into account in developing the protocols on gear amounts, and additional requirements on gear specifications incorporated. Consideration should be given to requiring tagging of nets to facilitate quantification and identification of lost gear.**
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Longlines (Hook and Line)

Baited hook and longline fisheries are viewed by the majority of participants as one of the most conservation friendly of all the gear types used in the Eastern Canadian fishery. While there are some problems associated with the catch of non-target species, including seabirds in some areas on groundfish gear if set during daylight, and the gear is not that size selective, the ability to ghost fish is lost quickly and bottom disruption is limited to the breaking off of above seabed structures such as worm tubes. It is claimed widely that hook and line fisheries would probably never knock stocks down to the levels seen in recent times. It is worthy of note, however that when the longline fishery (referred to as the bull tow at the time) first became popular in the late nineteenth and early twentieth centuries, it was hailed as the ruination of the Newfoundland northeast coast fishery. The impact on the stocks is more a question of how much effort is deployed, rather than the nature of the gear itself so that excessive effort can still be applied. Furthermore, this gear sector has also been subject to considerable technological improvements, not only to the lines and hooks, but also in handling techniques, boat design, electronic fishfinding and positioning equipment, artificial bait and chemical attractants.

The common theme throughout the public consultations on the conservation aspects of gear was that very little is wrong with this gear. While most felt that there is little that could be done to improve the size and species selectivity of this gear because bait size could not be regulated easily, there were suggestions that improvements could be still made in some fisheries by changing the size of hook permitted and the type of hook permitted.

Danish (Scottish) Seine

Danish (Scottish) Seining originated as its name implies in Denmark and was subsequently adapted to its present form in Scotland. It is a very common groundfish gear and is considered to be very efficient in catching slow-swimming, bottom-dwelling species such as flatfish. While this gear is sometimes lumped with otter trawl, the two gears are very different in their manner of fishing and the extent of their use. It is claimed that the impact of this gear on the bottom will be different to that of otter trawls as there are no doors, but the footrope may make more contact with the bottom. However like otter trawling, there can be problems with the catch of small fish and non-target species.

In recent years there have been significant changes made to this gear through the introduction of square mesh, large diamond mesh, lastridge ropes, and sorting grates. Discussion on this type of gear was limited in our consultations, due to the fact that the gear is not widely used outside the southern Gulf of St. Lawrence.

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Cod Traps

The cod trap has been used extensively throughout most of Newfoundland and Labrador, and to some extent on the Quebec Lower North Shore, since it was developed in the late eighteen hundreds. It is a very efficient method of catching fish, capable of catching large volumes of fish in short periods of time when they are available to the gear, and this efficiency has increased over time, and particularly with the introduction of the Japanese trap in the 1960s. It is used exclusively near shore. The most significant problem with the cod trap is its capacity to catch large quantities of small cod, quantities which are so small as to be discarded.

While there was almost unanimous agreement that the small fish problem in cod traps needs to be remedied, the suggestions on how this would best be accomplished are varied. They range from increasing the mesh size throughout the trap, to increasing the mesh size dramatically in all parts of the trap except the drying twine, particularly as meshing of small fish can be a problem in mesh sizes above 3.5" Some suggested that there has not been enough research done on how best to minimize the catch of small fish, so that studies need to be undertaken to determine the most appropriate approach. In any event, the cod trap is an important form of harvesting technology in three cod stocks, 2J3KL, 3Ps, and 4RS3Pn, and as such, action must be taken to remedy the small fish problem associated with this gear.

A second problem concerns bycatch of other species, particularly those where populations are low such as salmon and various whale species. Regulations require the return of all salmon to the water, whether dead or alive and considerable work has been done on discouraging whales from approaching traps. Additional work to prevent incidental harvest is warranted.

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3. **Research be expedited on methods, including alternative designs, of encouraging the escapement of small cod, and of non-target species such as salmon, before the trap is dried up.**

Technological Development

Over the past fifty years, tremendous changes have taken place in the fishery in Eastern Canada. The development of new technologies, both on the boat and in the water, coupled with better vessel design and construction and the development of new materials and designs of fishing gear has dramatically changed and increased our ability to catch fish. We now have at our disposal the capacity and technology to fish at any time and almost anywhere. Many people point to these changes and our inability as industry, scientists and managers to factor in this increased catching power, as one of the key reasons for the stock collapse of the late eighties and early nineties. Others consider these changes as improvements in efficiency that should not be looked upon as negative or necessarily anti-conservation.

In virtually all fleet/gear sectors, the ability to fish has increased through use of new fishing materials and electronic or hydraulic equipment advances. Today's trap skiff can easily fish four to six large cod traps per day through use of better hauling equipment. Only 10 to 20 years ago, trap crews could handle only two traps of smaller size and they required more crew members. Advances in other fixed gear technology permit gillnetters to deploy 1000 or more gillnets up to 200 miles from shore while longliners utilize automatic baiting and hauling systems and there have been great advances in hook design. Similar advances in trawling technology permit today's small dragger vessels (45-65 feet) to use trawls that only "offshore:" vessels used 10 to 15 years ago, and large stern trawlers can now fish in almost all weather conditions and seasons, utilizing the latest fish and gear monitoring technologies available. In all cases, electronic equipment, particularly high powered sounders (hydro-acoustics) ensure that the fish have nowhere to hide.

Beyond the use of advanced electronics, acoustic and hydraulics, today's fishing vessels have considerably greater distance/weather capabilities than their predecessors of comparable size. What would have been regarded previously as inshore/nearshore vessels, today fish to the full reaches of Canada's continental shelf, including those areas which extend beyond 200 miles. Vessel design improvements, new construction materials and technologies as well as technological advances in anti-roll tanks and stabilizers, all contribute to the construction of larger capacity vessels even when regulatory restrictions limit the overall length of the vessels.

All these elements mean that measuring the amount of fishing effort has become very complex. It is not correct to equate a day's fishing effort of 10 years ago with a day's effort by the same sized vessel at the present time. If there had not been these changes in the harvesting efficiency, any change in fishing success would be attributable to changes in the abundance of the resource and perhaps learning by the fishing crew.

Fisheries science has relied traditionally on using changes in fishing success as an indicator of changes in the abundance of the resource, but has been careful to try and take into account the differences in gear type, vessel size, season, etc., when interpreting patterns of fishing success. The differences used are those that can be measured easily such as vessel length, fishing methods, etc. What cannot be measured easily, and what has not been factored into stock assessments in the past, are the improvements in harvesting efficiency that have been the result of the developments discussed above. Consequently one of the important aspects of conservation with respect to gear technology is the development of an understanding of those increases in harvesting efficiency and thus how much an increase in catch rate is due to technological improvement, or indeed the extent to which technological improvement has masked a declining resource by "propping up" the catch rates. The problem can be restated as being an inability to determine how much more fishing mortality is being exerted by each vessel, each year.

A more obvious example of technological change is when a new fishery is developed, be it in an area previously not fished for that species, or due to the introduction of a new technology where a fishery already exists. Such developments will have two possible effects, one being to alter harvesting efficiency and the other to alter the impacts of fishing on the ecosystem.

A further concern about technological change is that not all elements of fishing gear may be modified in an appropriate manner at the same rate as others. This may generate problems for conservation if

modification of a gear type or of an existing fishery, while increasing harvesting rates, creates other problems. An example, is the extension of gillnetting into much deeper water than in the past which has required the use of heavier gear, particularly buoy lines and head ropes. However there is a tradeoff between lighter gear to facilitate the ease in handling the gear and heavier gear which reduces the risk of gear loss. This is of particular concern in the deep water Greenland halibut fishery off the East Coast of Newfoundland and Labrador. Another problem has been with respect to the introduction of square mesh in mobile gear fisheries. There is enhanced selectivity through such nets for roundfish, such as gadoids, but not for flatfish. Furthermore, when constructed of knotted, rather than braided, twine there is a tendency for the knots to slip.

As stated earlier, the question is, "Does it really matter how you kill fish, a dead fish is a dead fish?" In an ideal world, where we knew the exact size of the stocks and the full consequences of our harvesting efforts, on both the stocks and the ecosystem, it probably would not. However, our experience has been that we rarely know with any great degree of confidence, the health of the resource or the impacts on the ecosystem. When there are frequent changes to gear types and ever increasing efficiencies that are difficult to factor in, it becomes even more difficult to determine the size of the resource or the impacts on the ecosystem. In hindsight we have found that the good catches and the increased catch rates in some stocks have been, more often than not, the result of introducing a new piece of technology, the development of a new way of fishing or due to some other such development.

As well the focus of gear research in the past has tended in most cases towards increasing catching power and efficiency as opposed to making gear more conservation friendly. Developments that favour conservation have in most cases been a "by-catch" to work on the economics side of the equation. If fisheries are to be sustainable in the future we have to know the effect that the steady improvements in fishing efficiency, and the introduction of new methods and technology, will have on the resource and on our ability to manage the harvest.

We have to know what characteristics of fishing gear generate problems for the habitat or the resource and

Recommendations - Technological Development

1. **There be established immediately a Fishing Technology Review Group drawn from the fishing industry, fisheries management, science, particularly stock assessment, and the gear technology sector, with three primary areas of focus:**

   i) **to review new gear technologies before they are introduced to the fishery to ensure that each meets the conservation principles and objectives for gear use set forth in this paper.**

   ii) **to support research aimed at assessing and understanding the impact of existing and new technologies, as well as modifications to existing technologies, on the resource and the habitat.**

   iii) **to support research to understand the significance of past changes in technology and modifications of gear used on the efficiency of harvesting operations and the implications for scientific assessment of resource status.**

   iv) **to support research and the development of technology that will reduce, to the extent practical, the catching of under-sized fish and non-target species and also to reduce post-selection mortality.**

2. **There be a code of minimum standards for the construction for all gear types in all fisheries. These standards would address features of the gear that are important to conservation objectives.**

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be able to develop specifications that avoid these. We must ensure the gears we are using are appropriate and, yes, it does matter what type of gear is used to kill fish.

In order to address these questions, it is important that a forum be created for the effective integration of industry experience, fisheries technology, fisheries management and fisheries science, with respect to ecosystem and habitat research and, in particular, stock assessment. The latter point is emphasized because of the need to integrate the conclusions of the Review Group into stock assessments as well as into fisheries management.

Over-Capacity

The over-capacity problem in the Eastern Canadian fishery has been cited on numerous occasions previous as one of the main issues needing to be resolved if we are to have a sustainable fishery. As capital investment in both the harvesting and processing sectors has increased, so has the appetite for fish. The FRCC has in three previous reports cited over capacity as a major constraint to recovery of stocks. The problem is far too complex for an "easy fix".

The over-capacity problem in the fishery is not as simple as "too many people, chasing too few fish". The over-capacity problem in the fishery is directly related to the capacity of the fleet to harvest fish at levels above those that the resource can sustain, it is a gear and boats problem.

We have now at our disposal the capacity to fish virtually anywhere, at anytime. We have fished cod virtually through a frozen ocean in winter in 2J3KL. We have less than 65' gillnetters fishing upwards of 1000 nets for Greenland halibut in depths down to 800 fathoms, from the tail of the Grand Banks in the south, to Baffin Bay in the north. We have seen changes in the 80's in the cod trap fishery, both in the dramatic increase in the number of traps and the catching power of the trap itself (i.e: Japanese traps). We have also seen changes in hook and line where the fishing capacity has increased due to new hook designs and the availability of better hauling and handling technology on board vessels. We have the capacity to over-harvest every resource, and may have double that capacity, nor is that capacity static. In many areas capacity continues to grow, particularly through increases in the harvesting ability of the fleets, through vessel modernization and the ability to fish more gear, particularly gillnets.

Unless the capacity issue is resolved, it will not matter how much improvements can be made to conservation related aspects of gear technology, and fishing practices. They will not achieve their goal because the willingness to implement the changes will not exist when economic returns would be better by ignoring the conservation requirements for gear design and deployment, data collection, and other responsible fishing practices.

Enforcement

Throughout the public consultations on gear technology, the Gear Technology subcommittee was consistently told that the biggest problem with all gear types was the people who used them. The abusive practices of some fishermen are well documented and it is the view of the majority of those who attended the public consultations that those who abuse this right to fish should have that right removed. They pointed out, and quite rightly so, that however good the intent, regulations are of no use if there is not an effective way of enforcing them and an effective deterrent to breaking the rules.

Most people now accept that fines do not work. In some cases, they have been looked upon as the cost of doing business. The benefits of breaking the rules have in the past far outweighed any potential penalty if caught. We were told that the most effective way to achieve compliance was to remove fishing rights from those convicted of conservation related offenses.

Focusing on the activities of the "pirates on the waters" does not however, present a complete picture of abusive fishing practices. A number of these practices would not be possible without the complicity of other elements of the industry on shore. It is necessary therefore that adherence to regulations and conservation principles extend to all and thus get "the highwayman off the road".

Recommendations - Enforcement

DFO in conjunction with industry move as quickly as possible to ensure those measures already in place, as well as measures envisaged in Bill C-62 *Amendments to Fisheries Act*, such as sanctions, the provision of at sea observers, and on shore monitoring are enforced in a consistent manner.

CONCLUSIONS

For many years in the past, any consideration of fishing gear has been in the context of how to improve its efficiency and to reduce the cost of fishing operations, the two together providing greater economic return from harvesting activities. Any developments relevant to conservation aspects have largely been incidental, through measures to reduce drag on the bottom, to reduce meshing of the catch in the nets and to reduce gear loss.

The first conservation concern, although this is of long standing, addressed the capture of very small fish and lead to mesh size regulations, but recent events, such as the damage to coral reefs in tropical waters, and the major declines in groundfish stocks in many temperate areas, have greatly increased the awareness of possible adverse impacts of the action of fishing gear on the resource and its environment.

Much of the focus has been on otter trawling because this is the method that has expanded enormously since the 1950's and has contributed the major part of the great increase in harvest levels. There are many questions still to be resolved as to the extent of impacts on the resources and their environment caused by the action of harvesting, and on the significance of these impacts. It has proved very difficult to obtain the information needed to understand the effects. In particular, it has been almost impossible to separate out the various possible causes of changes in resource availability or to what extent there has been a mix of factors. Harvesting levels, abusive fishing practices, the impact of harvesting actions, environmental changes, or predation, are some of the more commonly discussed factors.

The conclusion to date would appear to be that any gear type can be destructive, depending upon the way it is used, but that the extent to which there are harmful effects also depends very much on the nature of the resource, its ecosystem and, in the case of towed bottom gear, the nature of the seabed. It is clear also that the "conservation friendliness" of all gear types can be improved.

A major concern is the management of fishing activity because some gear types are capable of making large catches in a short time, irrespective of location, biological behaviour of the fish, and season of the year. This translates into great concern about the excess capacity of the existing Canadian groundfish fleets, and the constant improvements in efficiency of harvesting operations, in terms of how effective the operations are in finding fish and catching them.

The FRCC draws attention to the critical need to reduce capacity if the economic demands to support the capital investments are not to compromise any measures introduced to improve the conservation aspects of the different fishing gears. A number of recommendations are made on ways of enhancing conservation both for fishing operations generally and for specific gears, particularly with respect to technological development; and to harvesting practices; and to gear design and specifications.

These recommendations reflect one or more of the Conservation Principles of this report, namely the need to protect the resource's ability to renew itself, the need to address the ecosystem aspects of harvesting, the need to be consistent between the different elements of fisheries management and throughout the range of each stock; the need for all involved to be accountable for the impact of their actions on conservation; the need for complete, accurate and timely information and analysis, and the need to take a precautionary approach when there is scientific uncertainty.

The Report identifies many areas where knowledge must be improved in order to understand the significance of the many possible conservation related aspects of fishing and the use of the different gear types, and makes recommendations as to priority areas for investigation. We recognize that a great many measures have already been implemented to enhance conservation, and this report does not

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attempt to purport to be the complete answer. There are innovative management measures in place, such as small fish protocols and Conservation Harvesting Plans. These can be enhanced greatly by implementing the recommendations in this report. There are a number of fisheries that are closed or under severe restriction that may be reopened or expanded in the future and the best opportunity to make changes is now. We recognize that constant changes are being made in harvesting efficiency, and associated with changes are severe financial restrictions. The Report has not, in general, identified who should do what, other than that all players must make the necessary changes to ensure conservation: the sustainable use of the resource.

Future analyses and scientific studies will likely be undertaken by Government and the Universities, but the role of the fishing industry is fundamental in supplying information, knowledge and experience, and in being the ultimate implementors of change where needed. There must be effective collaboration in planning and research, analyzing the importance of the results and designing the means of applying the results.

There are many concerns, many possible problems, many things that can be done and much that requires further work when considering how the activities of harvesting Canada's groundfish resource relate to the goals of rational and sustainable use. The questions are here, rational use of the resource requires that these questions be answered. We cannot continue as before and risk a repetition of the past.

This report is not an end to discussion on gear and conservation, nor is it a solution to all the problems. What it hopes to do, is to act as a catalyst for future discussion and offer tools to incorporate its recommendations into practice.

APPENDIX A

FRCC Membership

A. FRCC Membership

Members:

Fred Woodman, Chairman
Dr. Jean-Claude Brêthes, Vice-Chairman
Michael Belliveau
Dr. Tony Charles
Frank d'Entremont
Sam Elsworth
Tom Hallett
Frank Hennessey
Dr. Paul LeBlond
Dr. Jon Lien
Dr. Victorin Mallet
Jones Sheehan
Trevor Taylor
Maureen Yeadon

Provincial/Territorial Delegates:

Bruce Ashley, Northwest Territories
Glen Blackwood, Newfoundland and Labrador
David Gillis, Prince Edward Island
Yvon Chiasson, New Brunswick
Jean-Paul Lussiaà-Berdou, Quebec
Clarrie MacKinnon, Nova Scotia

Ex Officio from DFO

Dr. Bill Doubleday
Dawn Nicholson-O'Brien
Barry Rashotte

FRCC Secretariat

Catrina Tapley, Executive Director
Denis Rivard
Renée Brisson
Linda Brisebois
Lisa Tenace
Michael Mancini

APPENDIX B

Mandate and Membership of Gear Technology Subcommittee

B. Mandate of Gear Technology Subcommittee

Committee Membership: Trevor Taylor (Chair), Fred Woodman, Sam Elsworth, Frank Hennessey, Maureen Yeadon, Victorin Mallet (Past Chair)

Support: David Balfour, Andrew Duthie, Darlene Smith, Steve Walsh, Fred Allen, David Rideout, Catrina Tapley, Denis Rivard, Renée Brisson

Purpose: Opinions regarding the appropriateness of fishing technology often reflect sector interests. There is less frequently a clear understanding of the conservation aspects of gear use. The purpose of this Subcommittee is to determine, for each harvesting technology, the conservation implications, optimum manner of usage and relative desirability from a resource conservation perspective. This will be based on an objective analysis of historical experience and current evidence concerning habitat impact, gear selectivity, inherent manageability, the potential for improvement or abuse of the technology, and any other relevant considerations.

Operation:

1) The Fishing Gear Technology Subcommittee will work closely with other experts, within and external to the Department of Fisheries and Oceans, involved in research and study of gear technology.

2) A Fishing Technology Advisory Board will be established to provide advice to the Subcommittee and to facilitate an exchange of information; the chairperson of the Advisory Board shall be an ex-officio member of the Subcommittee.

3) In the first phase of its work, the Fishing Gear Technology Subcommittee will:

   a) commission an independent and objective study, to be completed by March 1994, of the state of knowledge on conservation implications of fishing gears, based on existing international literature and on relevant experience

   b) use the results of this study to prepare for the FRCC a public discussion paper outlining the current state of knowledge on questions of gear technology. This report will describe conservation advantages and disadvantages of each gear technology, including the selectivity of each gear, the effect of stock abundance on the impacts of each fishing gear, the environmental and/or habitat impacts of each gear technology, manageability implications, and the potential for abuse.

4) In its second phase, the Subcommittee will continue to analyze results from the above-noted discussion paper, and may organize and conduct "Gear Technology and Fishery Conservation" workshops. The goal will be to bring to the FRCC appropriate proposals concerning gear technology or gear-oriented regulatory measures required for conservation of the resource.

Appendix C

Chairman's Summary of Consultations

C. Chairman's Summary of Consultations

During March and April, 1996, the Gear technology Sub-committee of the FRCC held seven public consultations throughout Atlantic Canada and Quebec, on the conservation aspects of groundfish gear technologies.

As was expected, the opinions expressed and the positions put forth were as diverse as the fishery itself. While some of the discussions wandered off into areas that were clearly outside the perview of this committee, there were many fruitful debates and positive suggestions.

This document is an attempt to summarize the discussion that took place in March and April. It is an attempt to put to paper the recommendations, and in many cases the concerns that we heard.

As the "Consultation Paper on Gear Technology" was the primary focus of discussion, to the extent possible the summary of consultations will categorize comments according to where they fit within this document.

Conservation Principles Applicable to Gear

Selectivity and Post-selection Mortality

Discussion around this section was quite intense in all meetings. While it is probably fair to say that there was general agreement with the four proposed principles, there were differences of opinion on the relative merits of some aspects of what was being proposed. Without exception, there was agreement that harvesting should occur across the range of sizes and year classes in the population. As well, there was agreement that incidental harvesting of non-targetted species must be kept to the lowest possible level(A.i.c.). There was general agreement with the principle that improved gear selectivity must not result in increased post-selection mortality, however there were those who suggested that even if there was increased mortality that selectivity should still be pursued since some are bound to survive. The other side of the argument was that unknown levels of post selection mortality resulting from increased selectivity could just hide a problem.

The most wide ranging debate in this section, took place in relation to the relative merits of allowing fish to spawn at least once before being susceptible to capture by any fishing gear. While there were many who agreed with this as a principle, there were a significant number who questioned the merits of it. Comments ranged from, "if we had not caught as much small fish we would not have this trouble" to, " it is neither neccessary, nor sufficient to allow all fish to spawn at least once". In general, most saw a need to protect small fish from excessive harvests, however, they agreed that it is not sufficient to just do that. In many cases there was a stronger emphasis placed on the need to protect the older fish, the large mature spawners. The point was made that the seal hunt was, for over a hundred years, primarily a juvenile harvest and that it was sustainable, the point being again that it is not so much the kind of fish that you take as it is the amount that you take.

Environmental Impact

While most agreed that the impact of fishing gear on the seabed must not be detrimental to the ecosystem, there was considerable debate as to what exactly detrimental meant and how one proves that a gear is detrimental. To some, detrimental meant irreversible damage which suggests something rather extreme, while others suggested that in some areas any disturbance could be detrimental. Groundfish gear effects on the seabed were compared to the effects of other fishing gears, ie.scallop drags, surf clam harvesters, etc., and it was generally agreed that the effect of groundfish gear was much less in comparison. However, there were many suggestions that in some areas, the habitat may be such that all or at least some mobile gear be prevented from fishing there.

Manageability and Potential for Abuse

Discussion was forced on this section. Although there was agreement with what was written in this section, there was some confusion as to how it applied to gear. Clearly the loudest messege was that those found to be using gear in a way that was contrary to conservation principles should be prosecuted to the full extent of the law, including where possible removal of the right to fish. As well there was concern expressed that in the past, management decisions were made without the conservation implications of those decisions being fully understood.

Technological Development

There were divergent opinions on the merits of evaluating technological developments prior to their introduction to the fishery. Some industry people saw this as an environmental impact study of sorts for fishing gear and supported it, while others supported it and thought it should be applied to the technologies presently in the fishery. While most agreed that there should be some way of knowing the impact of introducing new fishing gear to the fishery, particularly from a resource assessment perspective, it was pointed out that there are a number of technological changes, not just gear changes, that have an impact on the fishery.

Major Risks Identified by Gear Type

In the Consultaion Paper on Gear Technology the GTS identified the major problems, from a conservation perspective, associated with each gear type. There was general consensus that the risks identified were in fact the major ones, however finding a consensus on what to do to remedy the problems will be difficult, if not impossible. Although the GTS clearly stated that it is neither our mandate nor our intent to recommend the banning of any particular gear type, there were strong views expressed about the future of otter trawls in the fishery and to a lesser degree the future of gillnets. From a different perspective, while it was acknowledged that there are significant problems with gear, it was pointed out that there have in fisheries that are ongoing, been significant improvements made in fishing gear to make it more conservative.

A. Otter Trawl

As noted above there were strong views expressed about the future of this gear type in the fishery. There were many who recommended an outright ban. Others suggested that areas particularly sensitive habitats, juvenile areas, and spawning areas should be off limits to Otter trawling. There appears to be tremendous support in the industry for a move to square mesh for gadoid species. There were suggestions that knotless mesh would be better for square mesh as it prevents the slippage that occurs when knotted mesh is hung square. In flatfishes it was felt that diamond is much more selective and should be used except in areas where flatfish/gadoid mixes are prevalent, in which case large square mesh should be used. It was generally felt that the use of square mesh panels/codends, sorting grates, or combination square/diamond codends could achieve a very size and species selective fishery with this gear.

While there was discussion about the impact of otter trawls on the bottom, it was suggested that this is probably not a big problem. However, there were consistent suggestions that some areas should be off limits to mobile gear, or at least some types. Some fishers, both fixed and mobile gear fishers, sugggested that if trawling was permitted in these areas that it be restricted to "soft bottom gear", ie. trawls with rope chain or cable foot gear as opposed to rockhopper, rollers etc.

The participants in the consultations felt that the greatest risk associated with otter trawl, was the catching power and the potential for abuse that goes with it. It was felt that the best way to deal with the potential for abuse was to apply stiff penalties including removal of the right to fish, to those who were found to be abusing their fishing privileges.

B. Gillnets

As noted earlier, there was strong representation made to strictly limit the use of gillnets in the future. The concerns were driven by a feeling that gillnets have, in some areas, been largely responsible for the demise of the large breeders in a population. Some suggested that in future it is probably as important to set a maximum mesh size for gillnets as it is to set a minimum mesh size.

It was emphasized that lost gear and ghost fishing, is not a problem every where. In most areas there are very few nets lost. However, there were a variety of suggestions made on how the problem could best be resolved in areas where it is a problem. Construction standards were recommended as a way to ensure that the gear used is strong enough to stand the enveironment that it will be used in. As well, locator devices were thought to be a good idea particularly in fisheries such as the deep water Greenland Halibut fishery. In other areas fishers suggested limits on the number of nets, in conjunction with net tagging. The net limit would be set at number that could be tended in a reasonable period of time and the tags could serve as a control.

C. Longline (Hook and Line)

Most agreed that there was very little fault to be found with this gear. Its main problem is that it catches whatever happens to swim by and is hungry enough, and has a mouth big enough, to bite the bait. While there seemed to be no solution from a gear perspective, to the indiscriminate catching by species, there was some discussion on how to improve size selectivity. There was general agreement that bait size has a large bearing on the size of fish caught, however, it is obvious that bait size cannot be regulated. There were differing opinions on the merits of increasing hook size to increase fish size, however there seemed to be a consensus that as a rule circle hooks catch more small fish than J hooks.

D. Scottish (Danish) Seines

As with Otter trawl, there were recommendations to move to square mesh when directing for gadoids. When directing for flatfishes in an area where by-catch of gadoids is not a problem then diamond mesh provides the best selectivity. In mixed flat/gadoid fisheries it was felt that combination diamond/square codends could provide adequate selectivity. When trying to eliminate gadoids from the catch it was suggested that large square mesh codends provide the best opportunity for selectivity.

E. Codtraps

It is generally agreed that the main if not the only problem with codtraps is the predominance of small fish in the catch, especially in recent years. There were many suggestions as to why there was such a significant percentage of small fish in the catch of this gear type, from "that was all there was left to catch", to, "there was a market for the fish, so we directed for it".

Suggestions on how to remedy the situation were wide ranging. There were those who suggested that the gear should not be changed at all, that it did not cause the problem in the fishery, therefore there is no reason to change. Some suggested that the mesh size in the "drying work" be increased to allow for escapement of small fish. Others suggested that any increase in the drying twine would make cod traps unworkable, due to the problem of large amounts of meshed fish, and that a more workable solution would be to increase the mesh size in other parts of the trap to allow escapemant prior to "drying up" the fish. Most agreed that something should be done to reduce the catch of small fish but cautioned that moving very far on mesh size in codtraps would render them useless and as such would mean a ban on the gear.

General Discussion Points

It was emphasized that the best place to select out unwanted catch, to ensure survival, is at the point of capture, in other words on the bottom.

In addition while there was general agreement that Nordmore grates be mandatory in all shrimp fisheries, there was some representation for flexibility in this, particularly in areas and at times when catch rates are high.

In trying to solve the ghost fishing problem in some gillnet fisheries, there was considerable debate surrounding the merits of biodegradable hanging twine as a solution. Some thought that it could cause a problem in that there could be a greater potential for lost netting.

In addition to these points there were others made that are specific to gear although not from a conservation perspective. There was great concern expressed about the cost of gear conversion, in the event that mesh size changes are recommended. Fishers questioned who would be responsible for changing the gear that in some cases they have been a lifetime accumulating. They suggested a sufficient period of time be made available to convert gear if that is what is required, and that in fisheries that are opened, a phase in approach be taken.

As well, as noted earlier there is tremendous concern about the possibility that the fishery of the future will mirror the fishery of the past. There is tremendous concern about the amount of capacity that is sitting at the wharf ready for the fishery to re-open. There are many who firmly believe that something has to be done to prevent gear technology and fishing technology in general, from running away with us in the future, as they believe it did in the past. Although the comments were mostly made in the context of otter trawlers, it is fair to say, most feel that excessive harvesting power in any gear type is dangerous for the resource.

Appendix D
List of Consultations

D. List of 1996 Consultations

February 27	Gaspé, Quebec; Auberge des Commandants
February 28	Moncton, N.B.; Wedgewood Hall, Mountain Rd
February 29	Port Hawkesbury, N.S.; Auditorium of the Nautical Institute
March 1	Bridgewater, N.S.; Wandlyn Inn
March 12	Deer Lake, Newfoundland; Deer Lake Motel
March 13	Twillingate, Newfoundland; Lion's Club
March 14	Clarenville, Newfoundland; Lion's Club

Appendix E

List of Briefs Received

E. List of Briefs Received At The 1996 Consultations

A. Deer Lake, Nfld. - March 11, 1996

FRCC.96.GR.DL-1	Bay of Island Fisherman's Committee

B. Twillingate, Nfld. - March 12, 1996

FRCC.96.GR.TW-1	John Elliot, Inshore Fisherman

C. Clarenville, Nfld. - March 13, 1996

FRCC.96.GR.CL-1	Joe Edwards

D. Gaspé, Qc. - April 16, 1996

FRCC.96.GR.G-1	Leroy Loggo, Brilliant Cove Fishermen's Assn.
FRCC.96.GR.G-2	Gerald Fortin, Pêcheurs de poisson du groupe Forillon
FRCC.96.GR.G-3	Paul-René Caron, Association des pêcheurs cotiers de forillon

E. Moncton, N.B. - April 17, 1996

FRCC.96.GR.M-1	Zoel Breau, MFU
FRCC.96.GR.M-2	David Coon, Conservation Council of New Brunswick
FRCC.96.GR.M-3	Cptn. David Tait, Nordsea Limited

F. Port Hawkesbury, N.S. - April 18, 1996

FRCC.96.GR-PH-1	Percy Haynes, Federation of Gulf of Nova Scotia Groundfishermen
FRCC.96.GR.PH-2	Ralph Halliday, Chris Cooper, Evan Walters, Alan Clarke
FRCC.96.GR.PH-3	Doug Mackinlay, for Prof. Judith Swan, Dalhousie Univer.

G. Liverpool, N.S. - April 19, 1996

FRCC.96.GR-L-1	Claude Albert d'Entremont, Inshore Fisheries Ltd.
FRCC.96.GR.L-2	John Angel, (Shrimp Fishing Graphics)
FRCC.96.GR.L-3	Terry L. Farnsworth, handline fisherman & member of the Alliance of Inshore Fishermen's Groups

H. Briefs Received by Mail

FRCC.96.GR-1	Maurice Ouellette, Assn. des Crabiers Gaspésiens Inc., Grande-Rivière, Que. (translated)
FRCC.96.GR-2	Daniel Boisvert, Resource Management, DFO, Laurentian Region (translated)
FRCC.96.GR-3	W.J. Christie, Christie and Associates, Picton, Ont.
FRCC.96.GR-4	George Chafe, Petty Harbour, NF
FRCC.96.GR-5	Patrick Ryan, Pres. Can. Society of Env. Biologists, Mobile, NF
FRCC.96.GR-6	Wayne Squires, inshore fisherman, Trinity Bay, NF
FRCC.96.GR-7	Roland Hedderson, inshore fixed-gear fisherman, Straitsview, Nfld.
FRCC.96.GR-8	Nelson Roberts, Loomis Way & Norman Cull, Nfld.
FRCC.96.GR-9	William Bowles, Burgeo, Nfld.
FRCC.96.GR-10	Floyd Hawkins, Beaver Harbour, New Brunswick
FRCC.96.GR-11	Robert McCarthy, Bellevue, Trinity Bay, Nfld.
FRCC.96.GR-12	Jerome Kerrivan, Placentia, Nfld., (2 ltrs.)
FRCC.96.GR-13	Marvin Hughes, Brook, Nfld.
FRCC.96.GR-14	Laurence Outhouse, Islands Inshore Fishermen's Assn., Tiverton, N.S.
FRCC.96.GR-15	Sylvain Samuel, La Federation des Pecheurs Semi-hauturier du Quebec
FRCC.96.GR-16	Submission presented on behalf of various organizations in Nova Scotia (Larry Parsons - 4VN Hook & Line, et al)
FRCC.96.GR-17	Michael O'Connor, National Sea Products Limited

FRCC.96.GR-18	Graeme Gawn, MFU Local 9
FRCC.96.GR-19	Ben Kovic, Nunavut Wildlife Management Board
FRCC.96.GR-20	Raziuddin M. Siddiqui, retired DFO employee
FRCC.96.GR-21	Derek P. Jones, Newellton, Nova Scotia
FRCC.96.GR-22	Association des pêcheurs de poisson de fond acadiens
FRCC.96.GR-22B	" " " " (cont'd)

Appendix F
Reference List

F. Reference List

Auster, Peter J., et al, 1996. *The Impacts of Mobile Fishing Gear on Seafloor Habitats in the Gulf of Maine (Northwest Atlantic): Implications for Conservation of Fish Populations* in the *Reviews in Fisheries Science*, 4(2), CRC Press, Pages 185-202.

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Fisheries Resource Conservation Council. *Consultations Paper on Gear Technology*, Discussion Paper prepared by the Gear Technology Subcommittee. Ottawa. FRCC.96.TD.1, 1996.

Jones, J.B., 1992. *Environmental Impact of Trawling on the Sea Bed: A Review.* New Zealand, Marine Fisheries Res. Pages 26, 59-67.

Sangster, G.I., 1994. *A Review of the Survival of Fish Escaping from Fishing Gears* in the *Report of Subgroup on the Methodology of Fish Survival Experiements*. ICES/1994, B:8

Sinclair, A.F. and G.A. Chouinard, 1996. *Implications of increasing otter trawl mesh size to avoid catching immature cod: effects on spawning biomass, fishing effort and catch rates*. DFO Atl. Fish. Res. Doc. 96/135.

Trippel, E.A., O.S. Kjesbu, and P. Solemdal. 1997. *Effects of Adult Age and Size Structure on Reproductive Output in Marine Fishes*. in R.C. Chambers and E.A. Trippel, editors, *Early Life History and Recruitment in Fish Populations*. Chapman and Hall, New York. Pages 31-62.